

What is claimed is:

1. A hybrid rocket motor, comprising:

- a) a container having a first fluid reactant therein and an outlet;
- b) a main combustion chamber containing a first solid reactant therein;
- c) a first fluid reactant injector between said container and said main combustion chamber through which said first fluid reactant is injected into said main combustion chamber to be combusted with said first solid reactant;
- d) a precombustion chamber at a head end of said main combustion chamber;
- e) a second fluid reactant which is injected into said precombustion chamber; and
- f) a third reactant which is contacted with said second fluid reactant in said precombustion chamber to form a combustible propellant, wherein heat generated from combustion of combustible propellant heats said injected first fluid reactant.

2. A hybrid rocket motor according to claim 1, wherein:

said third reactant is fluid.

3. A hybrid rocket motor according to claim 2, wherein:

said second and third reactants are in a swirl in said precombustion chamber.

4. A hybrid rocket motor according to claim 1, wherein:

at least one of said second and third reactants is injected substantially tangentially into said precombustion chamber.

5. A hybrid rocket motor according to claim 1, wherein:

said injector extends along substantially an entirety of a length of said precombustion chamber, such that an annular nozzle for said precombustion chamber is defined around said injector.

6. A hybrid rocket motor according to claim 5, wherein:

said third reactant is solid.

7. A hybrid rocket motor according to claim 1, wherein:

said first and second fluid reactants are the same.

8. A hybrid rocket motor according to claim 7, wherein:

said second fluid reactant is plumbed from said first container.

9. A hybrid rocket motor according to claim 7, wherein:

said second fluid reactant is tapped from holes in said first fluid reactant injector into said precombustion chamber.

10. A hybrid rocket motor according to claim 1, wherein:

said precombustion chamber is located around or adjacent said first fluid reactant injector.

11. A hybrid rocket motor according to claim 10, wherein:

said precombustion chamber includes a recirculation zone forward of said first fluid reactant injector.

12. A hybrid rocket motor according to claim 1, wherein:

said first fluid reactant is an oxidizer, and said first solid reactant is a fuel.

13. A hybrid rocket motor, comprising:

a) a container having a first fluid reactant therein and an outlet;

b) a main combustion chamber containing a first solid reactant therein;

c) a first fluid reactant injector between said container and said main combustion chamber through which said first fluid reactant is injected into said main combustion chamber to be combusted with said first solid reactant; and

d) a precombustion chamber around at least a portion of said first fluid reactant injector, said precombustion chamber having,

- i) a first inlet for a second fluid reactant, and
- ii) one of (A) a second solid reactant and (B) a second inlet for a third fluid reactant which when combined with said second fluid reactant forms a combustible propellant.

13. A hybrid rocket motor according to claim 12, wherein:

said first fluid reactant is an oxidizer, and said first solid reactant is a fuel.

14. A hybrid rocket motor according to claim 12, wherein:

said second fluid reactant is an oxidizer, and said precombustion chamber includes said second solid reactant which is a fuel.

15. A hybrid rocket motor according to claim 12, wherein:

said second fluid reactant is an oxidizer, and said precombustion chamber includes said at least one inlet, wherein said third fluid reactant is a fuel.

16. A hybrid rocket motor according to claim 15, further comprising:

e) a second fluid reactant tank including said second fluid reactant, said second fluid reactant tank in communication with said first inlet.

17. A hybrid rocket motor according to claim 16, further comprising:

f) a third fluid reactant tank including said third fluid reactant, said third fluid reactant tank in communication with said second inlet.

18. A hybrid rocket motor according to claim 16, further comprising:

f) said second inlet is in communication with said first container, wherein said third fluid reactant is said first fluid reactant.

19. A hybrid rocket motor, comprising:

a) a container having a first fluid reactant therein and an outlet;

b) a main combustion chamber containing a solid reactant therein;

c) a main injector between said container and said main combustion chamber, said main injector having a face with a

plurality of pathways through which said first fluid reactant is injected into said main combustion chamber to be combusted with said solid reactant;

d) a second fluid reactant;

e) a third fluid reactant stored separately from said second fluid reactant;

f) a precombustion chamber at a head end of said main combustion chamber, said second and third reactants being combined and combusted in said precombustion chamber to generate heat adjacent said face of said main injector.

20. A hybrid rocket motor according to claim 19, wherein:

said first fluid reactant is an oxidizer, and said solid reactant is a fuel.

21. A hybrid rocket motor according to claim 19, wherein:

said second fluid reactant is an oxidizer, and said third fluid is a fuel.

22. A hybrid rocket motor according to claim 20, wherein:

said first and second fluid reactants are the same.

23. A hybrid rocket motor according to claim 22, wherein:

said second fluid reactant is stored in said first container.

24. A hybrid rocket motor according to claim 19, wherein:

said second fluid reactant is selected from the group of gaseous oxygen, liquid oxygen, triethyl aluminum, trimethyl aluminum, and triethyl borine, and

said third fluid reactant is selected from the group of propane, ethane and ethylene.

25. A hybrid rocket motor according to claim 19, wherein:

a mixture of said second and third fluid reactants is hypergolic.

26. A hybrid rocket motor according to claim 25, wherein:

said second fluid reactant is nitric acid and said third fluid reactant is aniline.

27. A hybrid rocket motor according to claim 19, wherein:

said main injector extends substantially through an entirety of a length of said precombustion chamber such that an annular exit nozzle for said precombustion chamber is defined about said face of said main injector.

28. A hybrid rocket motor according to claim 19, wherein:

said precombustion chamber includes a recirculation zone forward of said face of said main injector.

29. A hybrid rocket motor according to claim 19, wherein:

said second and third fluid reactants are swirled together.

30. A hybrid rocket motor, comprising:

a) a container having a first fluid reactant therein and an outlet;

b) a main combustion chamber containing a solid reactant therein;

c) a main injector between said container and said main combustion chamber, said main injector having a face with a plurality of pathways through which said first fluid reactant is injected into said main combustion chamber to be combusted with said solid reactant;

d) a precombustion chamber at a head end of said main combustion chamber;

e) a second solid reactant stored in said precombustion chamber; and

f) a second fluid reactant stored outside said precombustion chamber and adapted to be combusted with said second solid reactant,

wherein when said second fluid reactant is contacted with said second solid reactant and combusted therewith, heat is generated adjacent said face of said main injector.



31. A hybrid rocket motor according to claim 30, wherein:

said first fluid reactant is an oxidizer, and said first solid reactant is a fuel.

32. A hybrid rocket motor according to claim 19, wherein:

said second fluid reactant is an oxidizer, and said second solid reactant is a fuel.

33. A hybrid rocket motor according to claim 19, wherein:

said main injector extends substantially through an entirety of a length of said precombustion chamber such that an annular exit nozzle for said precombustion chamber is defined about said face of said main injector.

34. A projectile, comprising:

a) a motor having a forward end and an aft end, said motor including,

i) a container having a first fluid reactant therein and an outlet,

ii) a main combustion chamber containing a first solid reactant therein,

iii) a first fluid reactant injector between said container and said main combustion chamber through which said first fluid reactant is injected into said main combustion chamber to be combusted with said first solid reactant,

iv) a precombustion chamber at a head end of said main combustion chamber,

v) a second fluid reactant which is injected into said precombustion chamber, and

vi) a third reactant which is contacted with said second fluid reactant in said precombustion chamber to form a combustible propellant, wherein heat generated from combustion of combustible propellant heats said injected first fluid reactant;

b) a tubular body around said motor;

c) a nose portion coupled to said forward end of said motor; and

d) a nozzle coupled to said aft end of said motor.

35. A method of igniting a hybrid rocket motor, comprising:

a) providing a hybrid rocket motor having a forward end and an aft end, said motor including,

i) a container having a fluid first reactant therein and an outlet,

ii) a combustion chamber containing a solid second reactant combustible with said fluid first reactant and having a head end and an aft end,

iii) an injector between the container and the head end of the combustion chamber;

b) providing third and fourth reactants which when mixed together form a propellant;

c) mixing the third and fourth reactants at the head end of the combustion chamber to form the propellant;

d) combusting the propellant such that the head end of the combustion chamber is heated;

e) injecting the fluid first reactant through the injector;

f) heating the fluid first reactant by combustion of the propellant; and

g) combusting the heated fluid first reactant with the solid first reactant such that the hybrid rocket motor is ignited.

36. A method according to claim 35, wherein:

the fluid first reactant is an oxidizer and the solid second reactant is a fuel.

37. A method according to claim 35, wherein:

the second and third reactants are fluids.

38. A method according to claim 37, wherein:

said mixing includes swirling the second and third reactants together.

39. A method according to claim 35, wherein:

the second reactant is a fluid and the third reactant is a solid.

40. A hybrid rocket motor, comprising:

a) a container having a fluid reactant therein and an outlet for said first fluid reactant;

b) a main combustion chamber provided with a solid reactant for said first fluid reactant;

c) an injector between said outlet of said container and said main combustion chamber through which said fluid reactant is injected into said main combustion chamber;

d) a precombustion chamber at a head end of said main combustion chamber which receives a fluid oxidizer; and

e) a catalyst provided in said precombustion chamber which catalyzes with said fluid oxidizer to form a catalyzed oxidizer.

41. A hybrid rocket motor according to claim 40, wherein:

said fluid oxidizer is said first fluid reactant.

42. A hybrid rocket motor according to claim 41, wherein:

said fluid oxidizer is piped to said precombustion chamber from said container.

43. A hybrid rocket motor according to claim 40, wherein:

said fluid oxidizer is  $\text{H}_2\text{O}_2$ .

44. A hybrid rocket motor according to claim 40, further comprising:

f) a fuel in said precombustion chamber which reacts with said catalyzed oxidizer.

45. A hybrid rocket motor according to claim 40, wherein:  
said catalyst is a solid.

46. A hybrid rocket motor according to claim 45, wherein:  
said catalyst is strontium nitrate on silver mesh.

47. A hybrid rocket motor according to claim 40, wherein:  
said catalyst is a fluid.

48. A hybrid rocket motor according to claim 46, wherein:  
said catalyst is a potassium permanganate solution.